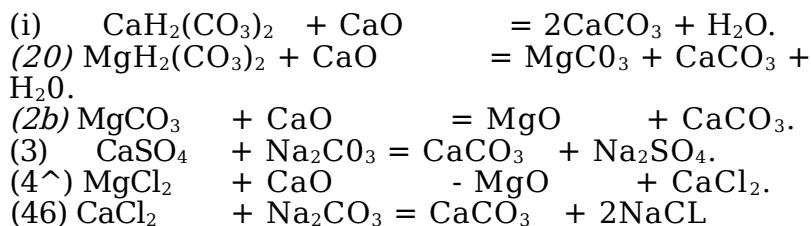


The method followed almost universally, on the ground of cheapness and adaptability, consists in mixing the water with lime-water and carbonate of soda in quantities previously ascertained by experimental tests.

PfeifTer gives the following equations as indicating the nature of the reactions:



The bicarbonates constituting the temporary hardness are precipitated by the lime in the form of carbonate in the case of the lime hardness and as oxide from the magnesia portion (equations i, za<sub>y</sub> and 2V). The sulphate of lime portion of the permanent hardness is decomposed by soda carbonate, its lime being precipitated as carbonate (equation 3), while the magnesium portion requires the conjoint action of the lime and soda carbonate to produce maximum elimination (equations 1a and 46). To determine the exact quantities of the two reagents required for a particular water the following tests may be applied:

Lime.—210 c. c. of sample is placed in a stoppered cylinder and lime-water of known strength added in considerable excess, the mixture shaken during 2 hr., settled or filtered, 70 c. c. pipetted off and titrated with

N

— HC1 first to phenolphthalein and then to methyl orange. The difference

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between the two is deducted from the figure obtained in the phenolphthalein

titration. The result gives the lime present in excess of what is actually needed.

Soda.—70 c. c. of sample is placed in a platinum basin and excess of

N

— Na<sub>2</sub>CO<sub>3</sub> added, the solution is evaporated nearly to dryness and then

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somewhat diluted, and the precipitate washed with air-free water. The excess of soda carbonate in the filtrate is then found by titration with

N

$\text{H}_2\text{S0}_4$  (methyl orange).

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The addition of the reagents to the water and separation of the precipitated sludge is carried out in a variety of appliances designed for the purpose by firms specializing in this line of engineering, and these work more or less automatically. It ought to be borne in mind, however, that natural waters are not constant in composition, and that for this and for other reasons such appliances will not continue to work satisfactorily without supervision.

Much of the disappointment that has followed the installing of water-softening apparatus results from unreasonable expectations of what it can perform. Periodic testing of the treated water ought not to be omitted.

Boiler Fluids.—Where, for one reason or another, it is not thought